INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ
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Table of Contents

2 Business Decision Theory

A business (firm) is formed on the basis of division of labour and specialization arising out of it. It is a designation of an economic and legal entity currently forming one of basic forms of organization of economics. The **business** is a system which is a summary of elements and relations arranged among them in a certain structure and that has a purposeful function. The **firm** can be characterized as an entity specialising in production, i.e. in transforming sources (inputs) into goods (outputs). For the purposes of this text, we shall consider the terms "firm" and "enterprise" as synonymous. On the final product market, businesses then form the supply side. Production inputs are called **production factors** which are processed into final outputs (goods and services) by means of technology. The relationship between inputs and outputs is described by means of a production function. **The production function** is the relationship between the quantity of production inputs (work, ground, capital, energy and others), which were used in production, and maximum volume of outputs (products), which were created by means of inputs in the period given. Outputs of the firm shall depend mainly on:

- ⇒ quantity of used inputs
- ⇒ efficiency of utilization of inputs (technology selection)
- ⇒ time horizon

Alfred Marshall (1842-1924) deserves most of the credit for applying the element of time in economy. *"The unit of time may be chosen according to the circumstances of each particular problem: it may be a day, a month, a year, or even a generation: but in every case it must be short relatively to the period of the market under discussion. It is to be assumed that the general circumstances of the market remain unchanged throughout this period."* (Principles of Economics by Alfred Marshall, 1890). In **the very short run**, production is fixed since production inputs cannot be changed in a very short period of time, and therefore, outputs are constant. In **the short run**, only some of production factors can be changed – so called variable production factors, which are generally referred to by the term **labour *L***. So called fixed production inputs, generally referred to as **capital *C***, are constant in the short run. It means that in the short run, outputs can grow, however, only to a certain extent in relation to the amount of variable inputs which we use in the production together with the constant amount of fixed capital. In **the long run**, all production factors (both the amount of labour L and amount of capital C are variable in the long run) can be changed. The firm outputs can be radically changed in dependence on the amount of variable labour and capital inputs used.

2.1 Short-run production function

The short-run production function can be written as follows:

$$TP_L = Q = f(K_1, L), \tag{2.1}$$

where Q (TP_L) is the total output produced per unit of time by means of production inputs, K represents the quantity of capital per unit of time used in the production Q, L represents the quantity of labour per unit of time used in production of Q.

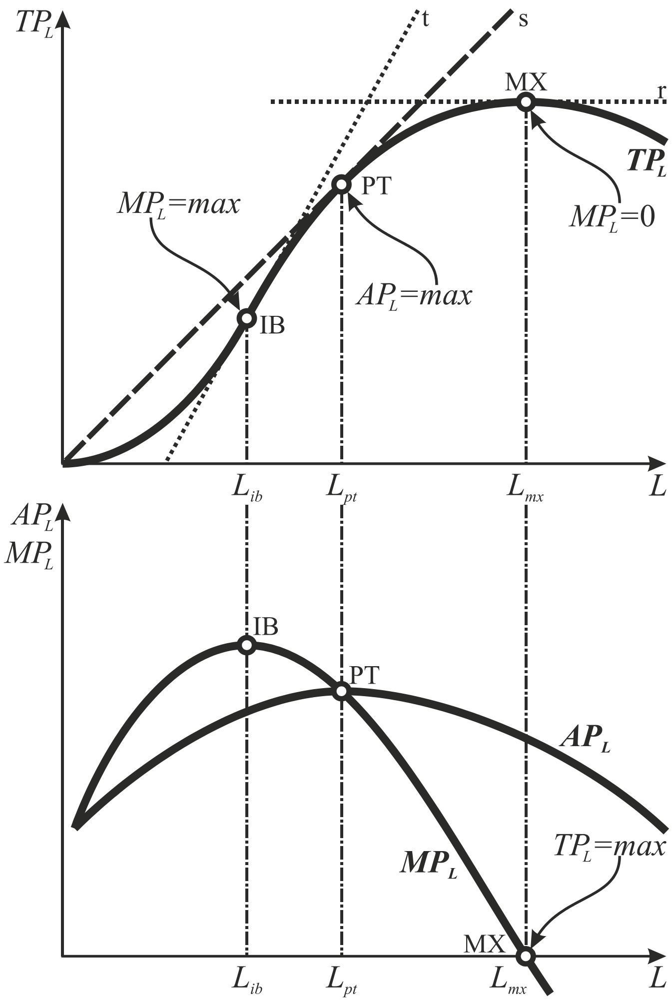
The analysis of the short-term production function shall be made while applying knowledge from the basic course of Microeconomics I. The graphical representation of the production function in the short run is so called **total (physical) product *TP*** which is dependent on the used quantity of fixed capital K_1 and variable input of labour L. The most ordinary shape of the curve of the total product of labour TP_L is the result of changing **returns from variable labour inputs**. **The average product of labour AP_L** represents the total product divided by the number of labour input units L, i.e. it expresses average output per unit of variable labour input. **Marginal product of labour MP_L** expresses an **additional output** or increase in the total output TP_L, which is produced by an additional unit of variable labour input (provided that other inputs remain constant). Mathematically, the average and marginal labour product can be written by means of equations:

$$AP_L = \frac{TP_L}{L} \tag{2.2}$$

$$MP_L = \frac{\Delta TP_L}{\Delta L} = \frac{\partial TP_L}{\partial L} \tag{2.3}$$

At the same time, we can state that by adding marginal labour products from the quantity $L_0 = 0$ up to any specific quantity of hired workers L_n, it is possible to specify the quantity of the total labour product while employing the given L_n workers.

$$TP_L(L_n) = \sum_{i=0}^{n} MP_L(L_i), \text{ resp. } TP_L(L_n) = \int_{i=0}^{n} MP_L(L_i)\, dL \tag{2.4}$$



2-1 Short-run production function

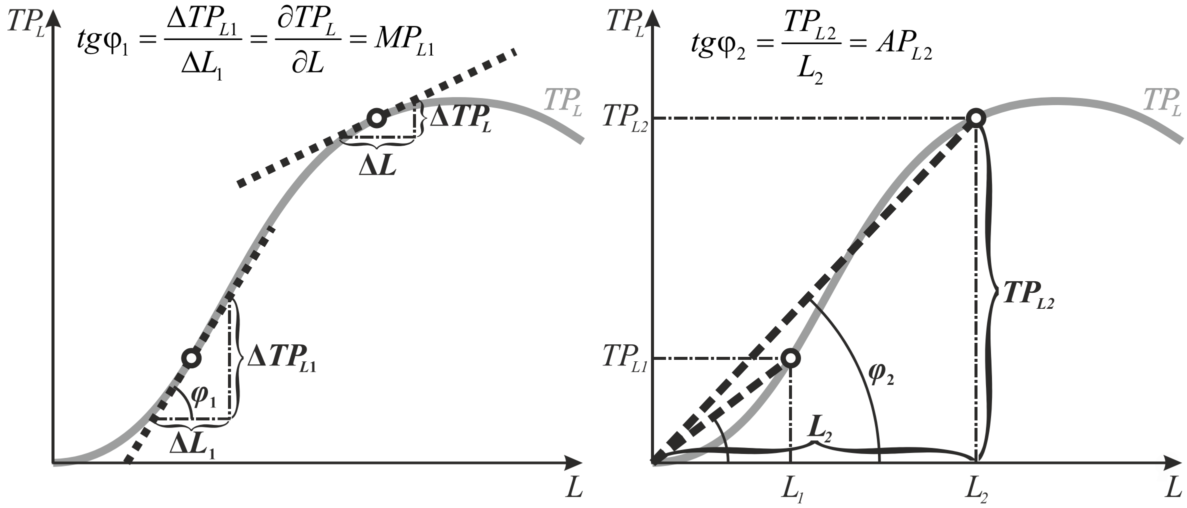
⇒ In the graph 2-1, the point IB is an **inflection point** at which the firm maximizes the marginal labour product. In the interval (0 – L_{ib}), the marginal productivity of labour grows, **growing returns from variable labour inputs** are enforced in the production. From the point L_{ib}, increments to the total product start to gradually decrease, the marginal labour productivity falls; adding the higher quantity of labour than L_{ib} into the production generates **diminishing returns from variable labour inputs** (from L_{ib}, the law of diminishing returns is pursued). The average product of capital AP_K grows (the total output increases and the quantity of capital is fixed).

$$AP_K = \frac{TP}{K} \tag{2.5}$$

⇒ The point PT (ray – tangent) is the point of maximization of average product of labour. To this point, the efficiency of all used inputs grows; the average product of labour and average product of capital also grow; the total product is increasing. The production phase in the interval ($0 - L_{pt}$) is positive with regards to the use of production factors and is described as the **production phase I**.

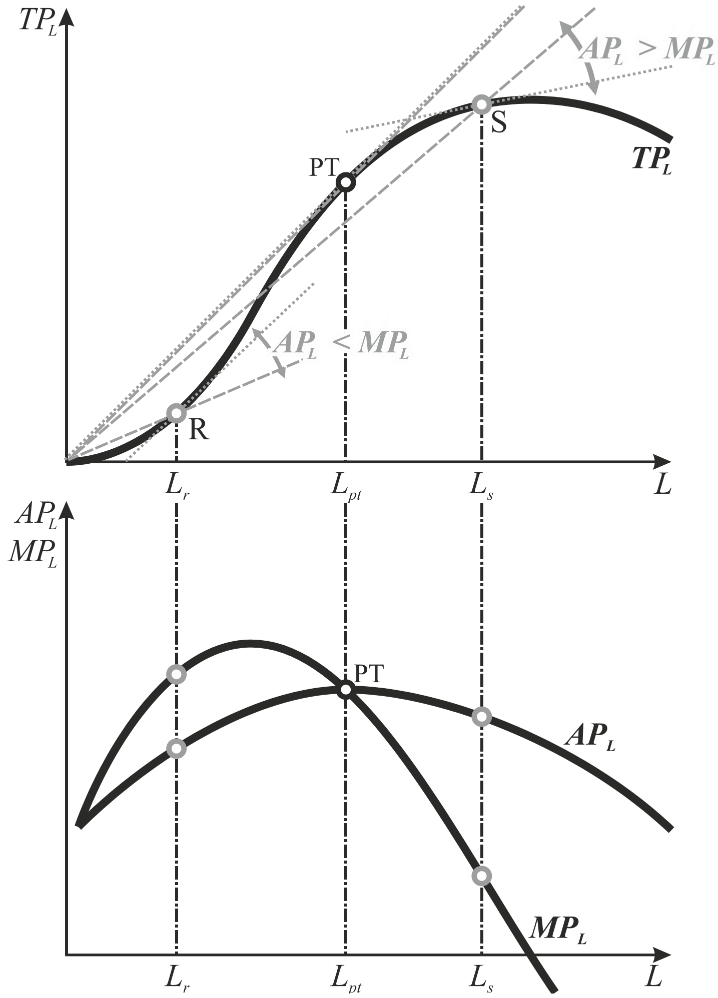
⇒ At the point MX, the firm maximizes the total product of labour. In the interval ($L_{pt} - L_{mx}$), the average product of labour falls, however, the average product of capital keeps on growing; the total product of labour is increasing slower and slower up to the maximum where the marginal product of labour is zero and the average product of capital reaches its maximum. This interval ($L_{pt} - L_{mx}$) is an optimal phase of production process and is described as the **production phase II**.

From the graph, the marginal and average quantity can be further derived. The course of marginal quantity (in this case, MP_L) can be estimated according to changes in the slope of the tangent led to any point of the total quantity. The course of average quantity (in this case, AP_L) corresponds to changes in the slope of the ray led to any point of the total quantity (see the graph 2-2).



2-2 Deriving the marginal and average quantity from the function of the total product of labour

The relationship between the average and marginal quantity, i.e. between AP_L and MP_L, is shown in the graph 2-3. The point PT is the point of maximum of the average quantity and at the same time, the point of equality with marginal quantity. At this point, the marginal product of labour intersects the average product of labour from above. In the graph 2-3, the situation is shown by means of rays (AP_L – dashed line) and tangents (MP_L – dotted line) to the total product of labour. In the interval where the slope of the ray is smaller than the slope of the tangent, $AP_L < MP_L$, the average product of labour rises. If $AP_L > MP_L$ (the slope of the ray is greater than the slope of the tangent), the average product of labour falls. It is also clear that at the point where the average product of labour reaches the maximum (i.e. it does not grow or fall), it must apply that $AP_L = MP_L$.



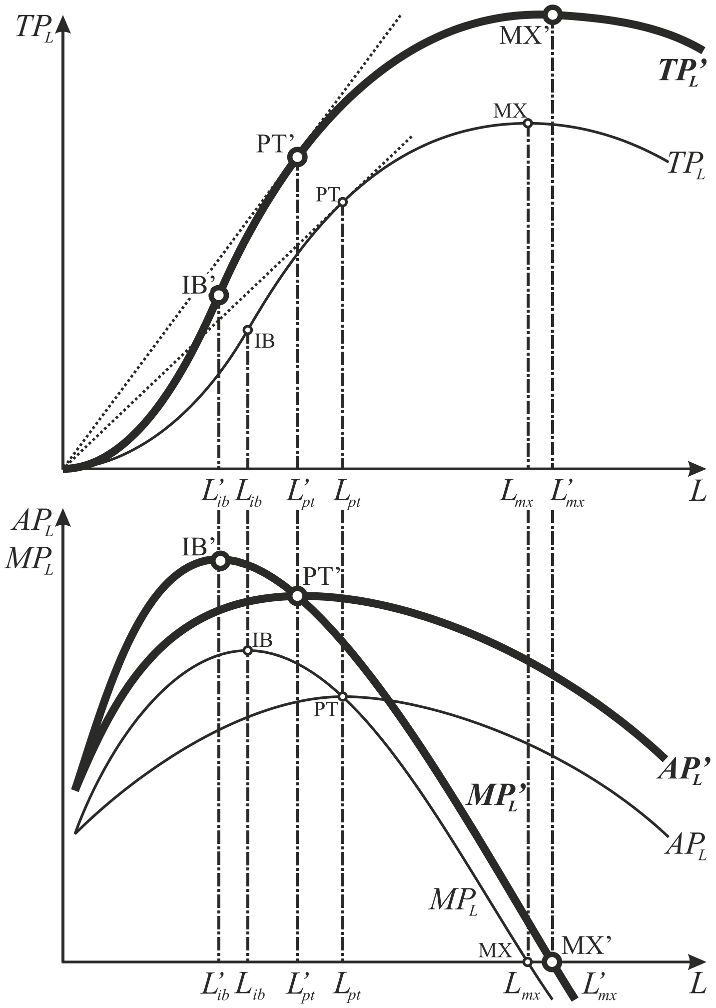
2-3 Relationship between the functions of marginal and average product of labour

The mutual relationship of the average and marginal quantity can be generalized:

⇒ **The marginal quantity is equal to the average quantity at the point of a local extreme of the average quantity (maximum or minimum).** The situation at the point where $L = 1$ where it naturally applies that $AP_L = MP_L$ is an exception.

2.1.1 A technological change between two short runs

When **capital resources are increased in the short run**, there is an increase in the total product manufactured, capital productivity and labour productivity are changed. The maximum marginal product of labour and average product of labour are reached while using a smaller amount of units of labour (see the graph 2-4).



2-4 Effects of increasing the capital stock between two short runs

2.2 Short-run cost curves

Based on the short-run production function, **short-run cost curves** can be derived. Costs represent the volume of funds purposefully spent on the purchase of production factors necessary in production of goods and services. Thus, the cost function is dependent on the volume of manufactured output and prices of production factors. The cost function can be expressed as follows:

$$TC = f(Q, w, r), \tag{2.6}$$

where r is the price of capital (*rate of interest*), w is the price of labour (*wage*) and TC are total costs. In the following analysis, we shall first suppose that the price of production factors remains constant with the quantity of used units of production factors.

The summary of costs is defined by the term "short-run total costs" (***STC***) which are divided into a flexible part and variable part. Fixed costs ***FC*** are associated with purchasing a short-run fixed input of capital, variable costs ***VC*** with purchasing a variable input of labour:

$$STC = FC + VC, \text{ where } FC = r \cdot K_1 \text{ and } VC = w \cdot L \tag{2.7}$$

In terms of real spending of costs, the costs can be divided into explicit and implicit costs. **Explicit costs** are costs of production factors really spent, quantifiable and accountable. **Implicit costs** are defined based on the possibility of alternative use of production factors when producing a different commodity (so called lost-opportunity costs). They represent alternative revenues from its use by someone else when producing another commodity which is not realized by the firm since it uses limited production sources for production of its own commodity. Costs of labour factors are generally considered as explicit costs. Costs spent on capital acquisition and use can be understood explicitly (amount for purchasing and using the capital in production) or implicitly (amount that anyone would be willing to pay for using the capital given in an alternative way).

Variable costs can be derived from the short-run production function (we consider the quantity TP_L identical to the quantity Q). The course of the curve of variable costs – similarly to the course of the curve of the short-run production function – reflects changing revenues from variable inputs of labour (see the graph 2-5).

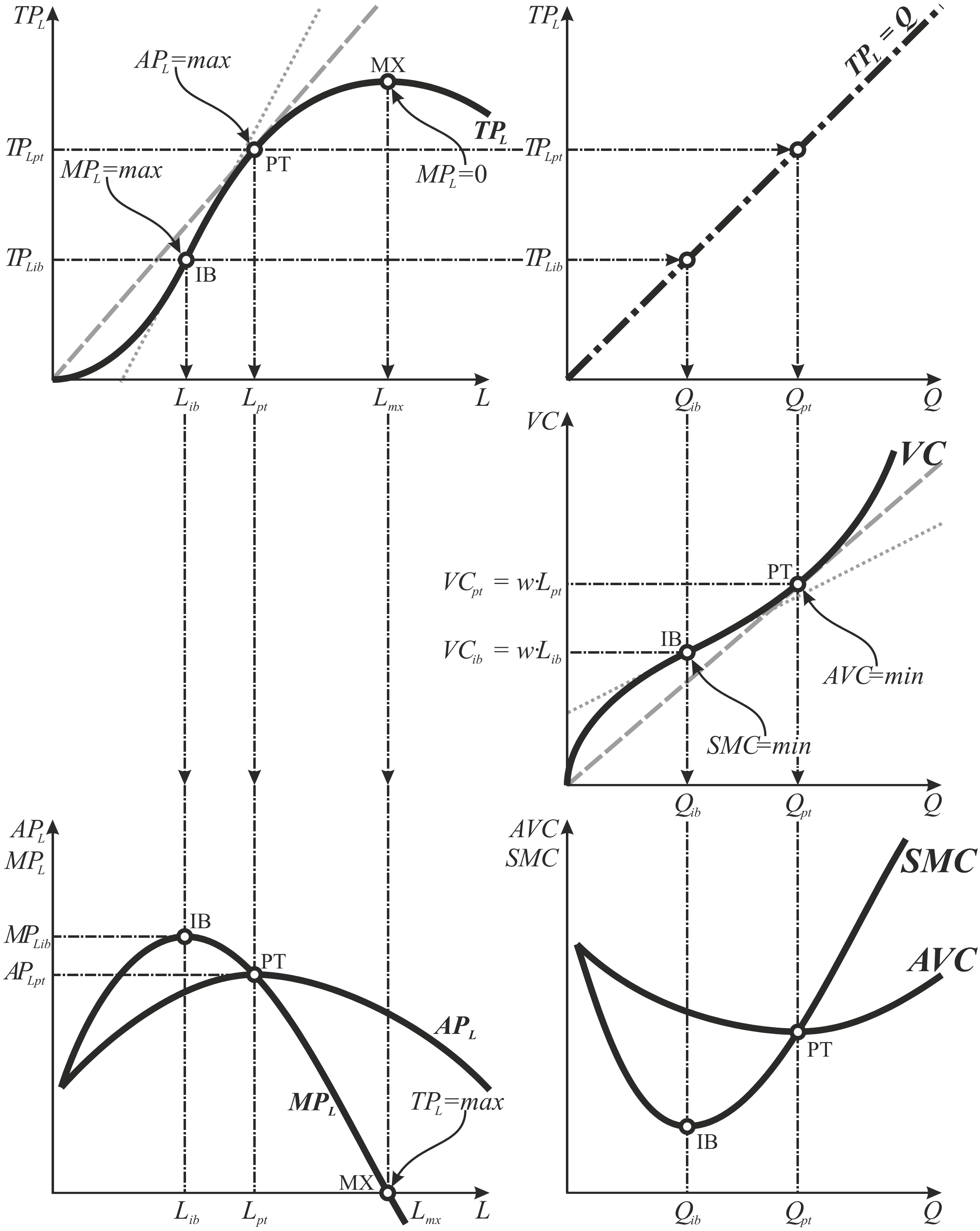
Unit cost quantities express the amount of costs per one unit of output Q. Short-run marginal costs ***SMC*** represent additional costs spent on producing another unit of output. Since the amount of fixed inputs is invariable in the short run (i.e. so is the amount of fixed costs), the short-run marginal costs represent the rate between the change in variable costs and the change in output.

$$SMC = \frac{\Delta STC}{\Delta Q} = \frac{\Delta \mathrm{VC}}{\Delta \mathrm{Q}} = \frac{\partial \mathrm{STC}}{\partial \mathrm{Q}} = \frac{\partial \mathrm{VC}}{\partial \mathrm{Q}}, \tag{2.8}$$

$$SMC = \frac{\partial \mathrm{VC}}{\partial \mathrm{Q}} = \frac{\mathrm{w} \cdot \partial \mathrm{L}}{\partial \mathrm{Q}} = \mathrm{w} \cdot \frac{1}{\mathrm{MP_L}}, \tag{2.9}$$

At the same time, we can claim that by summing marginal costs from the produced quantity $Q_0 = 0$ to any specific quantity Q_n, it is possible to define the value of the total quantity of variable costs necessary for production of Q_n output pieces from marginal costs.

$$VC(Q_n) = \sum_{i=0}^{n} SMC(Q_i), \text{ resp. } VC(Q_n) = \int_{i=0}^{n} SMC(Q_i)\, dQ \tag{2.10}$$



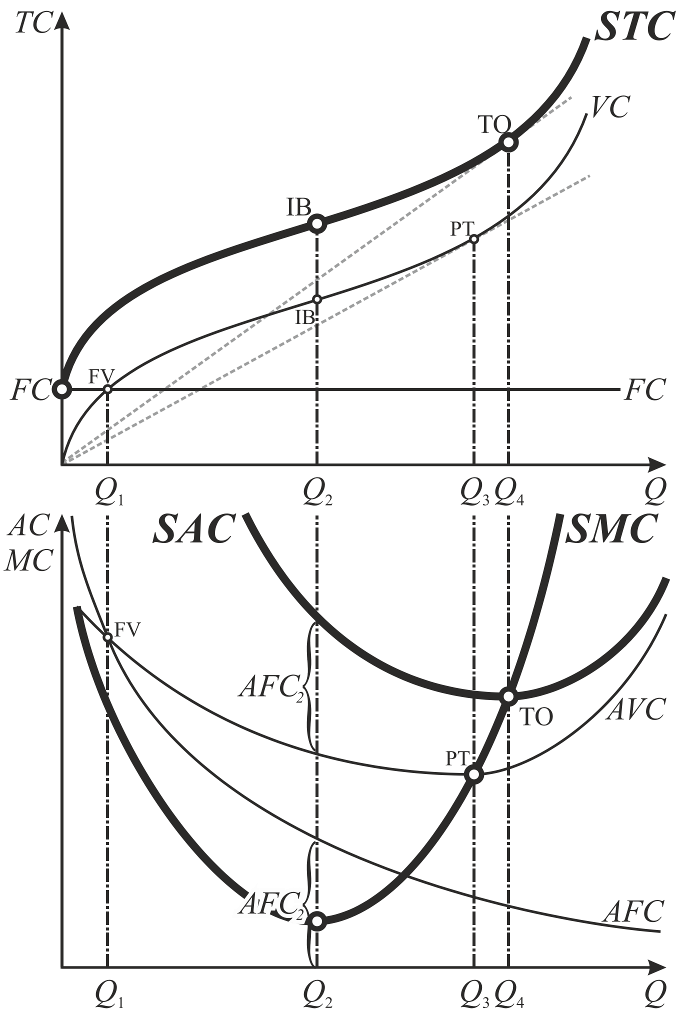
2-5 Relationship of short-run cost and production functions

Average variable costs ***AVC*** represent costs of variable labour input spent on one unit of output in average.

$$AVC = \frac{VC}{Q}, \text{ therefore } VC = AVC \cdot Q \qquad (2.11)$$

$$AVC = \frac{VC}{Q} = \frac{w \cdot L}{Q} = w \cdot \frac{1}{AP_L} \qquad (2.12)$$

The average variable costs are intersected by the short-run marginal costs from below at the point of minimum (see the graph 2-5).



2-6Short-run cost curves

Short-run total costs are the vertical sum of fixed and variable costs (see 2-6), i.e. variable costs are increased by the amount of fixed costs at each output level. Thus, the shape of short-run total costs exactly copies the shape of variable costs.

Based on the course of total quantities, we can further derive the shape of the curve of average fixed costs ***AFC*** which reflects the fact that with increasing production, smaller and smaller amount of fixed costs falls to each produced piece.

$$AFC = \frac{FC}{Q}, \text{ therefore } FC = AFC \cdot Q \qquad (2.13)$$

$$AFC = \frac{FC}{Q} = \frac{r \cdot K}{Q} = r \cdot \frac{1}{AP_K} \tag{2.14}$$

Short-run average costs ***SAC*** represent total costs divided by the number of produced units and represent the amount of costs falling to each output unit in average.

$$SAC = \frac{STC}{Q}, \text{ therefore } STC = SAC \cdot Q \tag{2.15}$$

However, we can also write the short-run average costs as the sum of average fixed and average variable costs since:

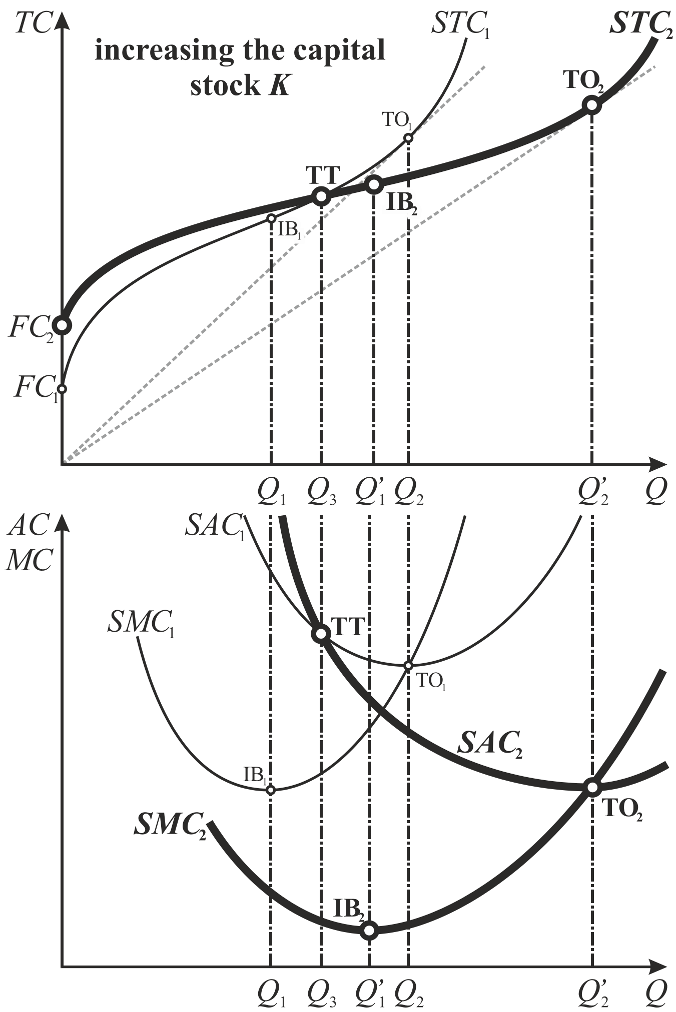
$$SAC = \frac{STC}{Q} = \frac{FC + VC}{Q} = \frac{FC}{Q} + \frac{VC}{Q} = AFC + AVC \tag{2.16}$$

The average total costs are intersected by short-run marginal costs from below at the point of minimum. This point is called **technological optimum of the firm TO.** The technological optimum is defined as a situation when the firm produces such a volume of production at which its average costs are minimal.

2.2.1 Technological change between two short runs

In the short run, the technological change requires increasing the capital. Since we have defined the short run as a time interval during which the amount of capital in the enterprise cannot be changed (and for this reason, fixed costs are also invariable in the short run), at this moment, we consider two consecutive short runs within the range of which there was a change in the capital of the enterprise.

The consequence of increasing the quantity of capital is a jump of labour productivity which shall result in a change in total and unit costs. The point TT (Q_3) is the point from which it is more profitable to use new technologies in production. At this point, $STC_2 = STC_1$ and at the same time $SAC_2 = SAC_1$. For the produced quantity higher than Q_3, the total costs STC_2 and average costs SAC_2 shall be lower than before the technological change. Thus, the technological change moves the point of technological optimum (point of minimum SAC) down to the right (from TO_1 to TO_2 on the graph 2-7).

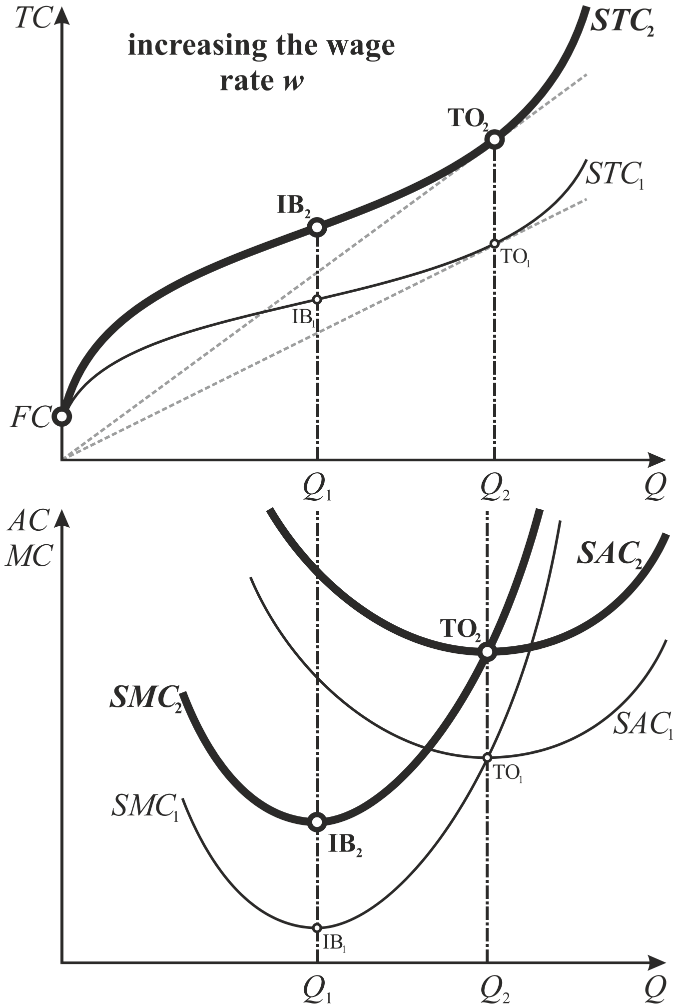


2-7 Effects of increasing the capital stock between two short runs

2.2.2 Increase in wage rates (labour price) in the short run

If the labour price (wage rates are increased) is changed at constant fixed costs and provided that all other variables influencing the production remain invariable, then, variable costs shall be increased within the whole course of theirs. Due to the increase in variable costs, the short-run total costs are also increased within the whole interval of produced quantity.

The increase in the total costs projects into a shift of short-run average and short-run marginal costs upwards in the vertical direction as shown in the graph 2-8. The produced quantity of the inflection point on the curve of the short-run total costs and the horizontal position of the technological optimum on the curve of the short-run average costs shall remain invariable, they only move vertically upwards since the amount of costs with which these points are reached is higher at a higher level of wage rates.



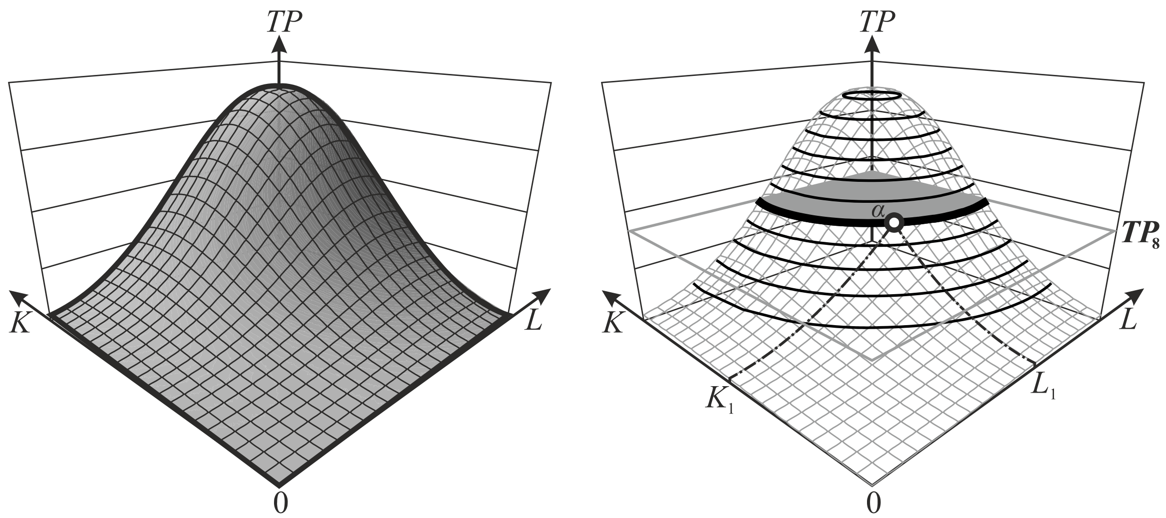
2-8 Effects of increasing wage rates in the short run

2.3 Long-run production function

A basic characteristic of the long run is the fact that the firm can change the amount of all used inputs, except for technologies, in dependence on the amount of manufactured output. All inputs are then variable. The production function is expressed by the relationship:

$$TP = Q = f(K, L) \tag{2.17}$$

The graphical representation of the long-run production function is an isoquant map which shall be created by the vertical projection of “contours”, a so called product hill, onto the horizontal plane (see the graph 2-9).



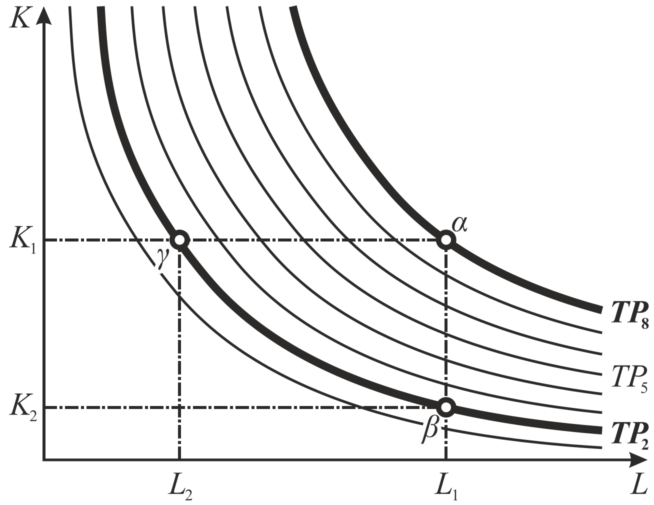
2-9 Product hill

2.3.1 Isoquant

An isoquant represents all combinations of two production factors K and *L* by means of which it is possible to produce the same number of output units. All the points on one isoquant are **productively efficient**, i.e. all combinations *K* and *L* ensure the same output level; they need not be technically efficient. **The technical efficiency** represents the state when the quantity of one production input cannot be decreased without increasing the quantity of the other production input when producing the same output quantity; i.e. the state when the marginal product of both production factors is nonnegative. Situations when the marginal product of one or the other production factor equals to 0 are specified by so called edge curves on the product hill (see the graph 2-9).

Isoquants are characterized as follows:

- ⇒ Isoquants are degressive (principle of substitution) and convex to the origin (principle of decreasing revenues).
- ⇒ Isoquants do not intersect.
- ⇒ Isoquants further from the origin represent higher manufactured output.
- ⇒ Only one isoquant goes through each point of the graph.

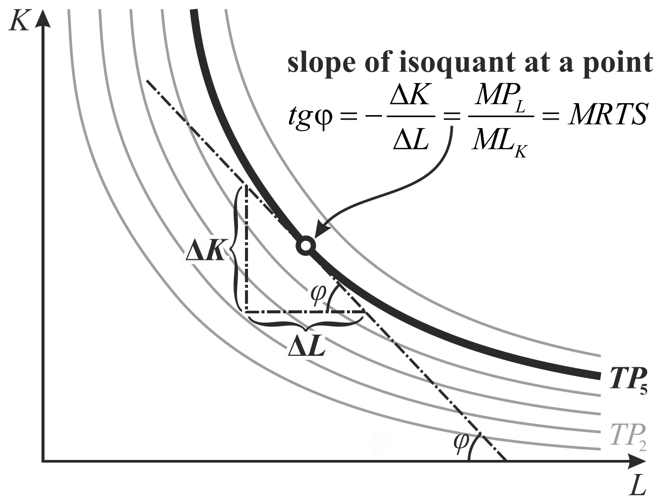


2-10 Isoquant map

The slope of the isoquant is determined as the **marginal rate of technical substitution *MRTS*** which specifies the amount of units by which the firm must increase the use of one production factor if it decreases the use of the other input by one unit without any need to change the output volume. It is the marginal rate of substitution of capital for labour. The firm decreases the quantity of capital ($-\Delta K \cdot MP_K$) and substitutes it by increasing the quantity of labour ($\Delta L \cdot MP_L$) at the same output level. It shall then be applied to the marginal rate of technical substitution:

$$MRTS = -\frac{\Delta K}{\Delta L} = \frac{MP_L}{MP_K} \tag{2.18}$$

If we increase the range of one production factor and if we decrease the quantity of the other production factor to preserve the same quantity of manufactured output (movement on the isoquant), then, the marginal rate of technical substitution (a rate of marginal products) shall fall and vice versa.



2-11 Marginal rate of technical substitution

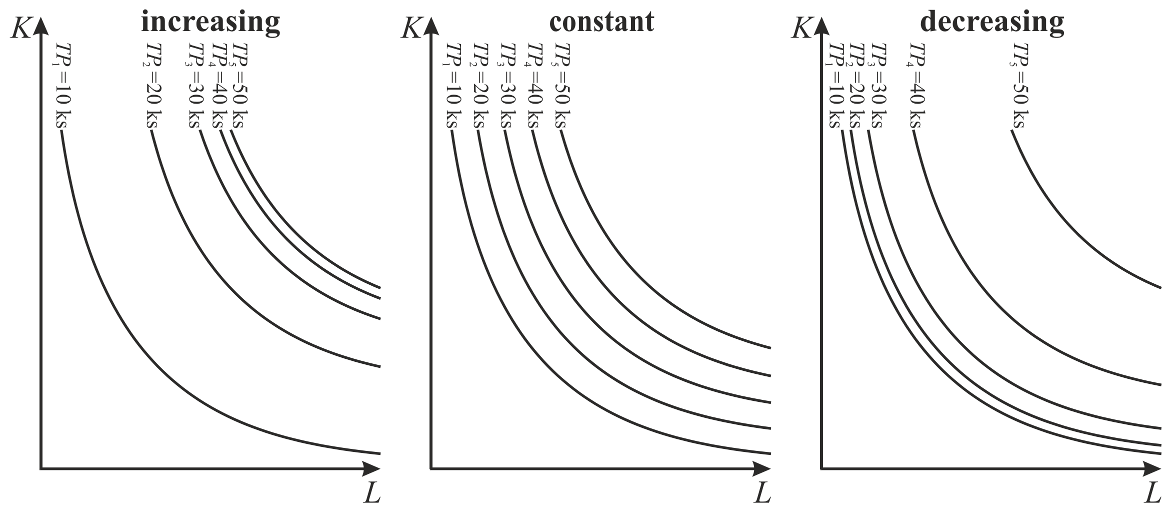
The elasticity of mutual substitution of production inputs is quantified by **elasticity of substitution**.

$$\sigma = \frac{\dfrac{\Delta(K/L)}{K/L}}{\dfrac{\Delta MRTS}{MRTS}} = \frac{\Delta(K/L)}{\Delta MRTS} \cdot \frac{MRTS}{K/L} \qquad (2.19)$$

2.3.2 Returns to scale

Returns to scale represent the relationship between a proportional change in inputs and a subsequent change in outputs. If the quantity of inputs is increased n-times ($n > 1$), then:

- ⇒ For constant returns to scale, it shall apply $f(n \cdot K, n \cdot L) = n \cdot f(K, L) = n \cdot Q$.
- ⇒ For increasing returns to scale, it shall apply $f(n \cdot K, n \cdot L) > n \cdot f(K, L) = n \cdot Q$.
- ⇒ For decreasing returns to scale, it shall apply $f(n \cdot K, n \cdot L) < n \cdot f(K, L) = n \cdot Q$.



2-12 Returns to scale on the isoquant map

The character of returns to scale can be plotted by means of the long-run production function where they become evident on distances between individual isoquants (see the graph 2-12).

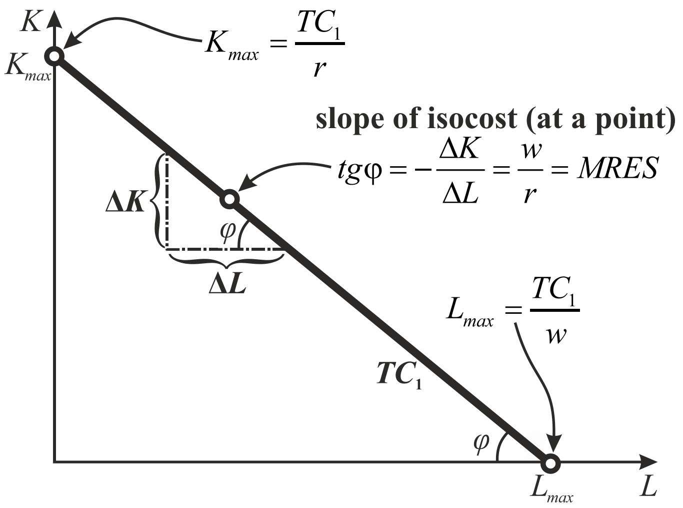
2.3.3 Isocost

An isocost connects all purchase combinations of production inputs K and L which must be spent on the same quantity of total costs TC. The equation of the isocost can be then written in the form:

$$TC = w \cdot L + r \cdot K \qquad (2.20)$$

The slope of the isocost can be determined by means of its gradient which determines the **marginal rate of economic substitution *MRES***, given by the rate of prices of production factors:

$$-\frac{\Delta K}{\Delta L} = -\frac{\partial K}{\partial L} = MRES = \frac{w}{r} \quad (2.21)$$



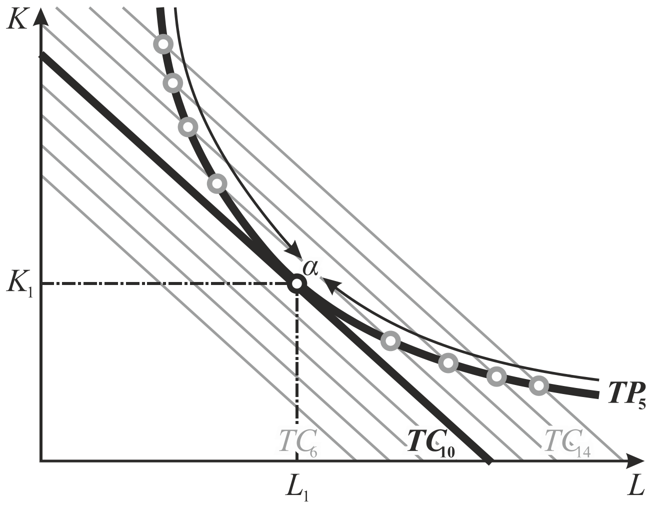
2-13 Marginal rate of economic substitution

For the **optimal combination** of inputs *K* and *L* in the production of *Q*, it must apply that the rate at which the firm is technically able to substitute the capital for labour (*MRTS*) equals to the rate at which it is able to realize this substitution on the market (*MRES*). Specifying the optimal combination represents **economic efficiency** of production. If the firm is economically efficient, it is also technically efficient as well as productively efficient; however, the contrary implication is not possible.

$$\frac{MP_L}{MP_K} = MRTS = MRES = \frac{w}{r}, \text{ or } \frac{MP_L}{w} = \frac{MP_K}{r} \quad (2.22)$$

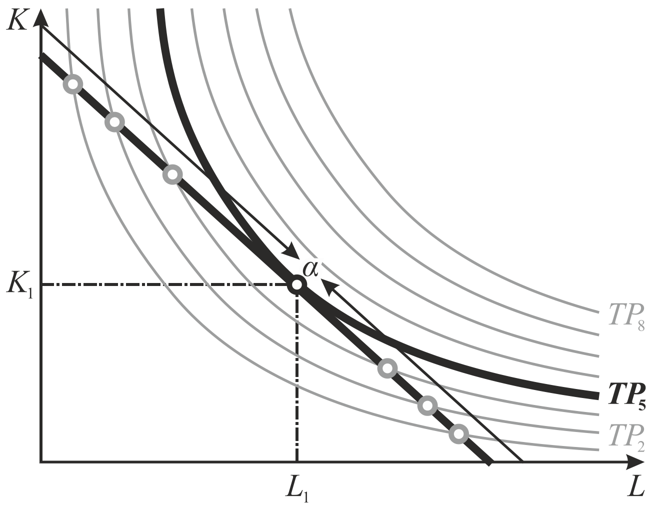
Graphically, the point of optimum is the point of contact of the isoquant and isocost. The producer's decision-making can run in two directions in dependence on the situation:

⇒ based on searching for **minimal costs** for the required quantity of manufactured output (movement on the isoquant, graph 2-14).



2-14 Reaching the optimum of the firm by means of cost minimization

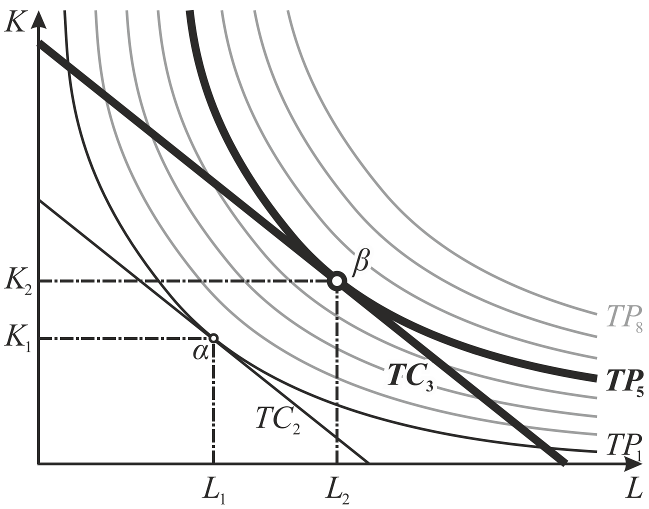
⇒ based on searching for the **maximum output** for the given quantity of costs (movement on the isocost, graph 2-15).



2-15 Reaching the optimum of the firm by means of output maximization

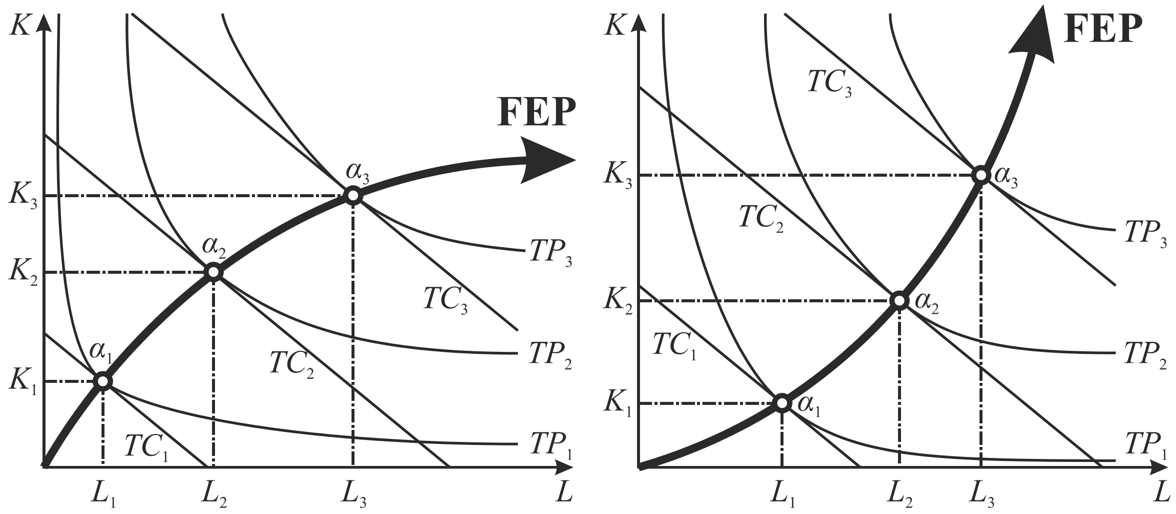
2.3.4 An increase in the total costs of the firm in the long run

The firm's expansion path FEP connects all points of optimal combinations of production inputs in the production of various output quantities provided that prices of production inputs are not changing with the volume of purchased inputs (*MRES* is constant). Since it applies to the optimal combination of inputs that *MRTS* = *MRES*, the marginal rate of technical substitution shall also be constant for all points on the expansion path. If the firm wants to increase the volume of manufactured output, it must hire a higher amount of production inputs at constant prices of production inputs which shall increase its costs.



2-16 Effects of increasing the total costs of the firm in the isoquant analysis

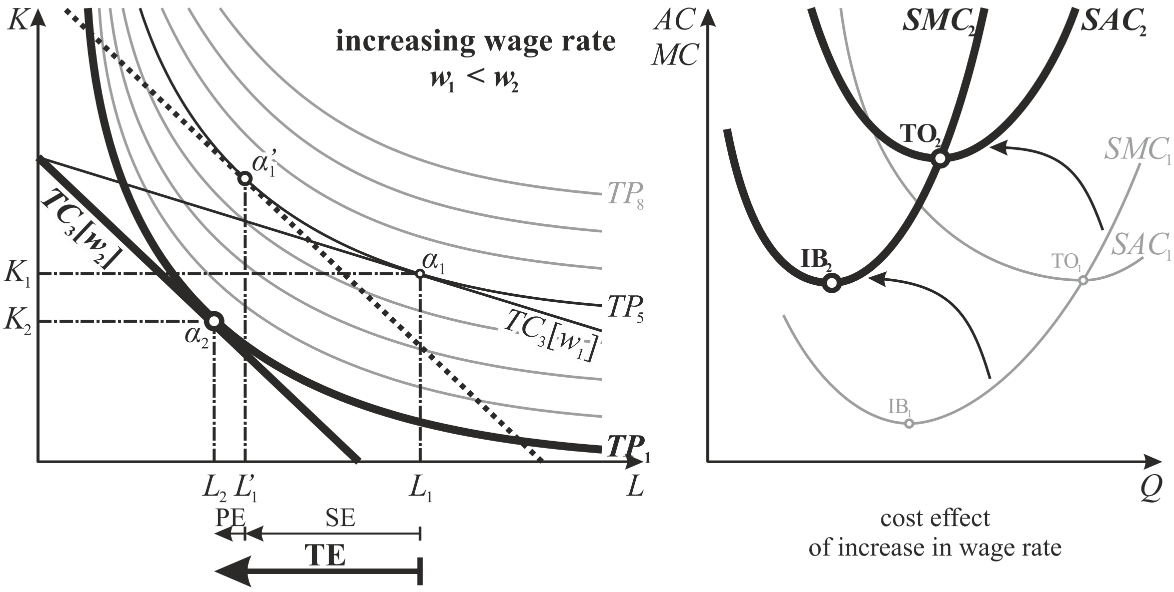
Based on the slope of the firm's expansion path, the production can be characterized as capital intensive production or labour intensive production (or production with the same labour and capital intensity).



2-17 The firm's expansion path for labour and capital intensive production

2.3.5 Increase in wage rates (labour price) in the long run

In contrast to the short run, a **change in prices of production factors** in the long run leads to new optimal distribution of labour and capital in production. An increase in the price of labour (from w_1 to w_2) shall result in substitution of labour for capital (substitution effect SE) and a decrease in the production as a result of increasing the price of the production factor of labour or a decrease in the real value of spent costs (production effect PE). The total effect is the sum of the substitution effect and production effect. The technological optimum moves up to the left, the firm's costs are increasing, the so called cost effect becomes evident.



2-18 Effects of increasing wage rates in the long run

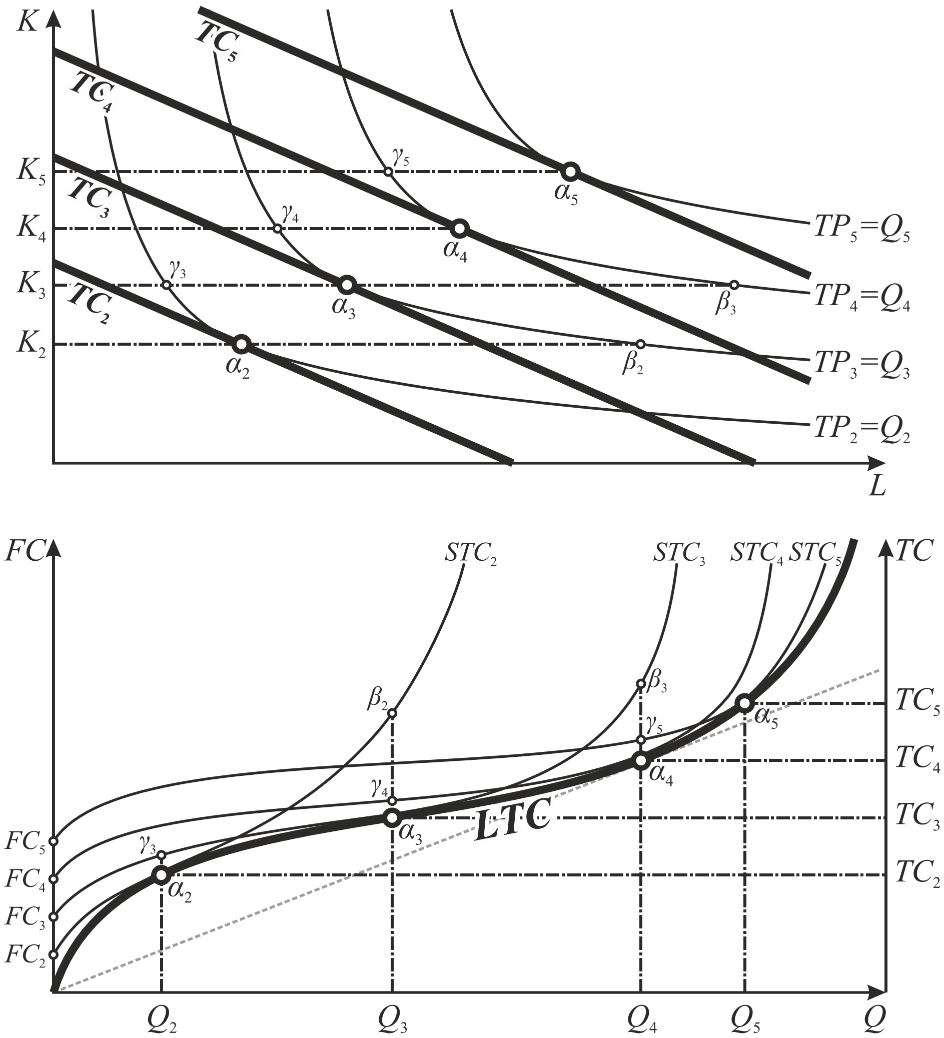
2.4 Long-run cost curves

Based on the long-run production function, **long-run cost curves** can be derived. **The long-run total costs *LTC*** are a summary of all costs associated with the production whereas production inputs are dependent on the volume of manufactured output. *LTC* surrounds individual curves of short-run *STC* from below, therefore, the *LTC* curve is called an envelope curve. In the short run, costs are associated with the fixed quantity of capital and variable quantity of hired labour, in the long run, there is an optimal variation for combination of used quantity of labour and capital. The shape of the *LTC* curve is determined by returns to scope.

$$LTC = w \cdot L + r \cdot K \tag{2.23}$$

Increasing returns to scope are enforced at the points $\alpha_2(Q_2)$ and $\alpha_3(Q_3)$, constant returns to scope at the point $\alpha_4(Q_4)$ and decreasing returns to scope at the point $\alpha_5(Q_5)$ as shown in the graph 2-19.

The short-run fixed costs FC_2 of the STC_2 curve are calculated based on the price of capital r and fixed quantity of capital K_2. An analogous approach is applied to all levels of capital K (or fixed costs FC). At the same time, the graph 2-19 shows that at the points of contact of the curve of long-run total costs with the curves of short-run total costs (points α), the total costs spent on the given output Q are the lowest. E. g. the quantity of the total product $TP_3 = Q_3$ can be produced by means of the technology K_2 at the total costs in the amount β_2 or by using the technology K_3 while spending the total costs α_3 and/or finally by using the technology K_4 requiring the short-run total costs in the amount γ_4. The lower part of the graph 2-19 shows absolutely clearly that the lowest costs spent on the production of the quantity Q_3 shall be spent by the firm while using the capital K_3. However, we would also come to the same conclusion using the upper part of the graph 2-19 if we led auxiliary isocosts through the points β_2 and γ_4, these would lie obviously farther from the origin (and thus, they would express a higher level of costs) than the isocost TC_3.



2-19 Relationship of the long-run costs and isoquant analysis

The long-run marginal costs and **long-run average costs** can be derived from the long-run total costs according to the same principle and while preserving the same relationships as in the case of the short-run costs. The mutual relationships of the short-run and long-run total and unit costs are shown in the graph 2-20. Both the graphs (2-19 and 2-20) indicate only a cut of four seasons (second to fifth), other short-run periods naturally precede and follow them.

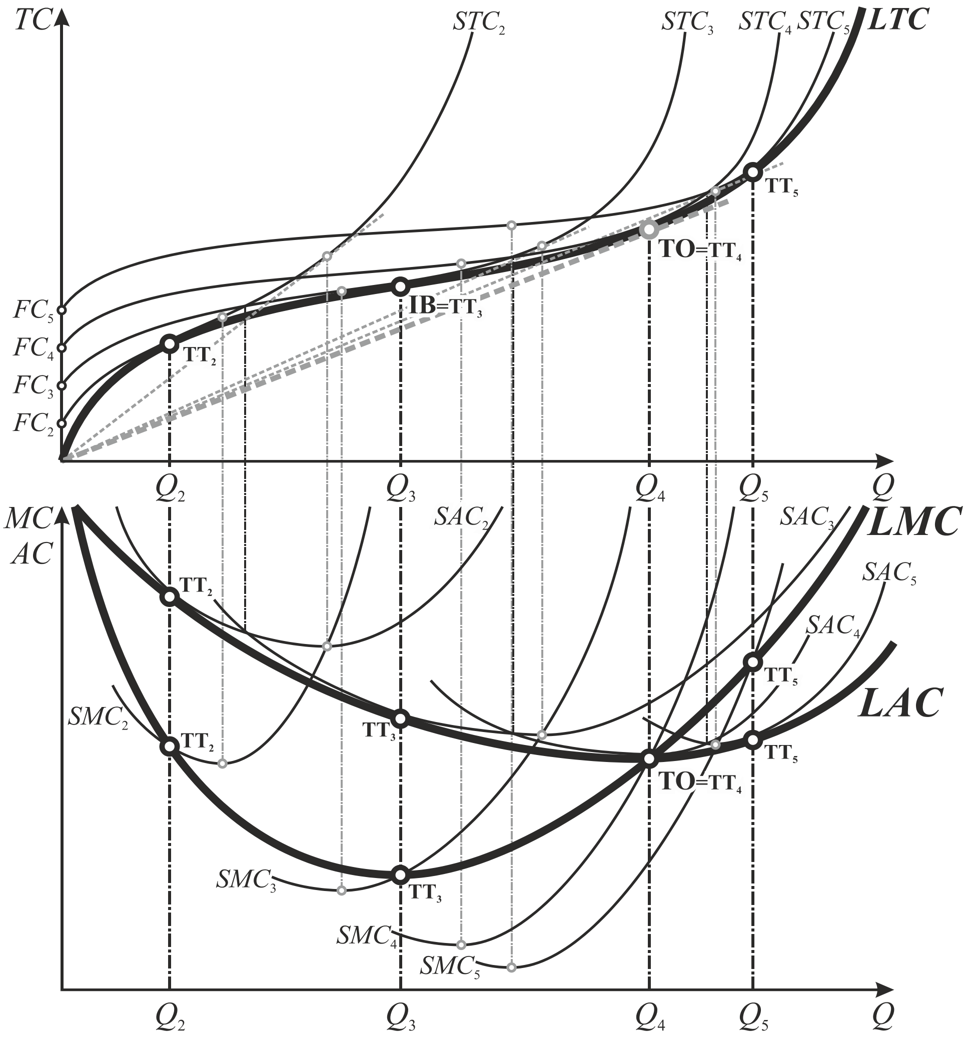
$$LMC = \frac{\Delta LTC}{\Delta Q} = \frac{\partial LTC}{\partial Q} \tag{2.24}$$

$$LAC = \frac{LTC}{Q} \tag{2.25}$$

The long-run average costs *LAC* as well as the long-run total costs *LTC* are called an **envelope curve**.

The long-run average costs cover short-run average costs whereas the points of contact represent the state when *SAC* are equal to *LAC*. The envelope curve expresses the long-run optimal technology usable for reaching minimal unit costs in the production of the given quantity of output. Growing returns to scope are enforced to the point TO in the production of the quantity Q_4, and further, the returns to scope decrease. In the production of the quantity Q_4, the point TO is the point of optimal production from the technological point of view when:

$$SAC = SMC = LAC = LMC \quad (2.26)$$



2-20 Long-run cost curves

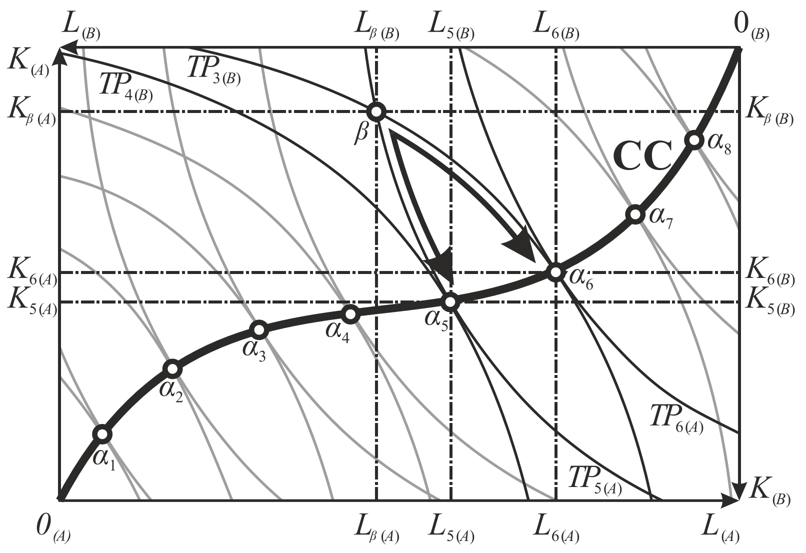
2.5 Production efficiency

Production efficiency is defined as the state in which it is not possible to redistribute a limited quantity of production sources among firms so that an increase in the production of one firm would not result in a decrease in the production of other firms at the given prices of production factors, i.e. by reallocating production factors, an improvement within the meaning of Pareto optimality cannot be achieved. The production efficiency can be characterized on the basis of three conditions, so called allocation rules.

2.5.1 The first allocation rule

The first allocation rule is focused on the distribution of production sources inside the firm so that *MRTS* of both production factors *L* and *K* for both produced commodities *A* and *B* would be the same and both the production sources would be fully used. For the graphical representation, we shall again use the Edgeworth production box-diagram the width of which is defined by the total disposable quantity of labour and the height of which is determined by the total disposable quantity of capital. The graph shows long-run production functions of the firm V turned by 180° against each other (the situation would be analogous for the firm *W*). The firm V produces two products *A* and *B* while using labour and capital (*L* and *K*). By connecting efficient allocations of labour and capital (points where the production of one commodity cannot be increased without the necessity to decrease the production of the other commodity), we get a **contract curve CC**, i.e. a set of all efficient methods of allocation of two production factors between two produced commodities. For all points on the contract curve CC, it applies:

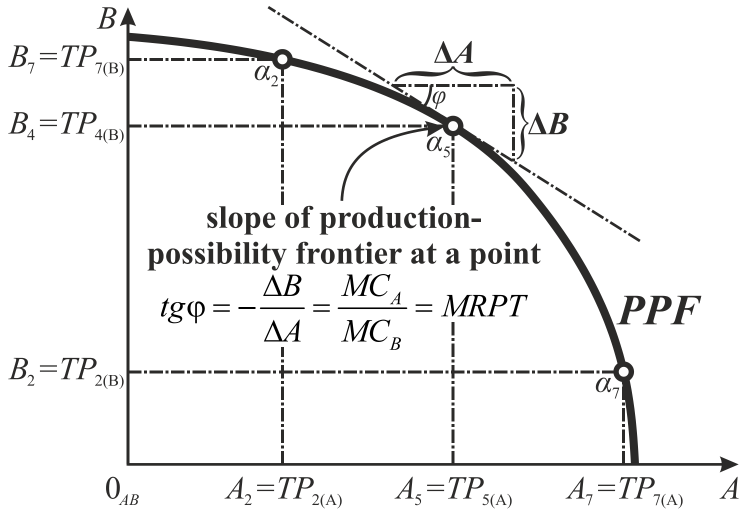
$$MRTS_{K,L(A)} = MRTS_{K,L(B)} \tag{2.27}$$



2-21 Optimal allocation of inputs between the production of products *A* and *B* in the firm

The production-possibility frontier (PPF), which shows alternative combinations of efficient production of two commodities *A* and *B* at a limited quantity of sources, can be derived from the contract curve CC. The gradient of the PPF curve expresses the **marginal rate of product transformation** (***MRPT***) which specifies what decrease in the production of one commodity must be achieved as a result of increasing the production of the other commodity at limited sources. If there is a limited (fixed) quantity of sources fully used in the production, then, in the course of PPF, total costs shall be constant at invariable input prices. Then, it applies:

$$MRPT = -\frac{\Delta B}{\Delta A} = \frac{\partial TC / \partial A}{\partial TC / \partial B} = \frac{MC_A}{MC_B} \tag{2.28}$$



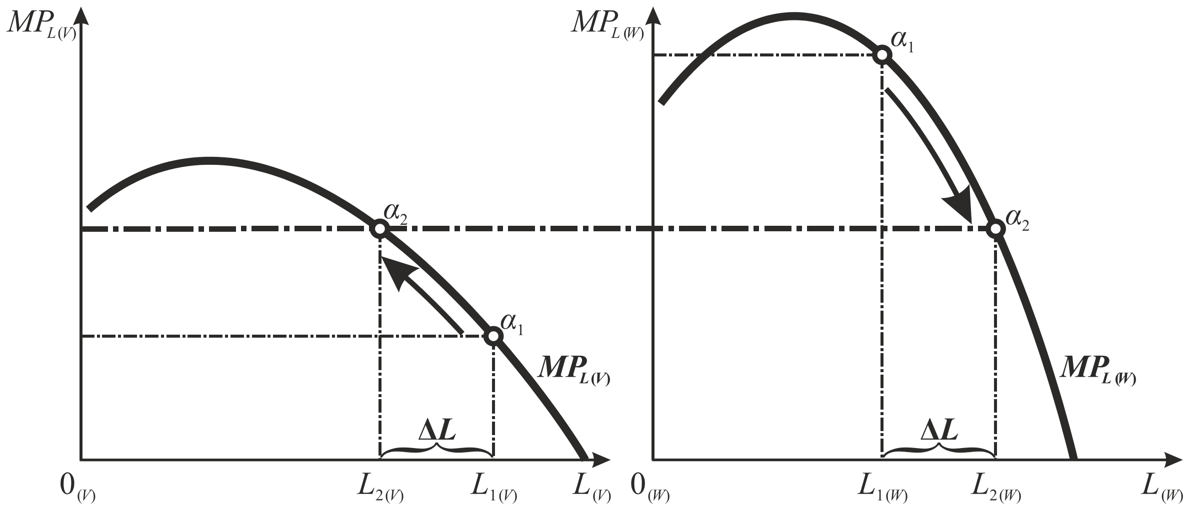
2-22 Production-possibility frontier

The production-possibility frontier PPF expresses alternative costs (lost-opportunity costs) and its shape is influenced by decreasing returns to a variable input, existence of specialized productions (specialized production inputs) and differences in labour and capital intensity of the production of the goods *A* (apples) and *B* (bananas).

2.5.2 The second allocation rule

The second allocation rule examines efficient distribution of limited production sources between two firms V and *W*. This efficiency is reached if the marginal product of the last used unit of both production factors *L* and *K* is the same by both the firms.

$$MP_{L(V)} = MP_{L(W)} \qquad MP_{K(V)} = MP_{K(W)} \tag{2.29}$$



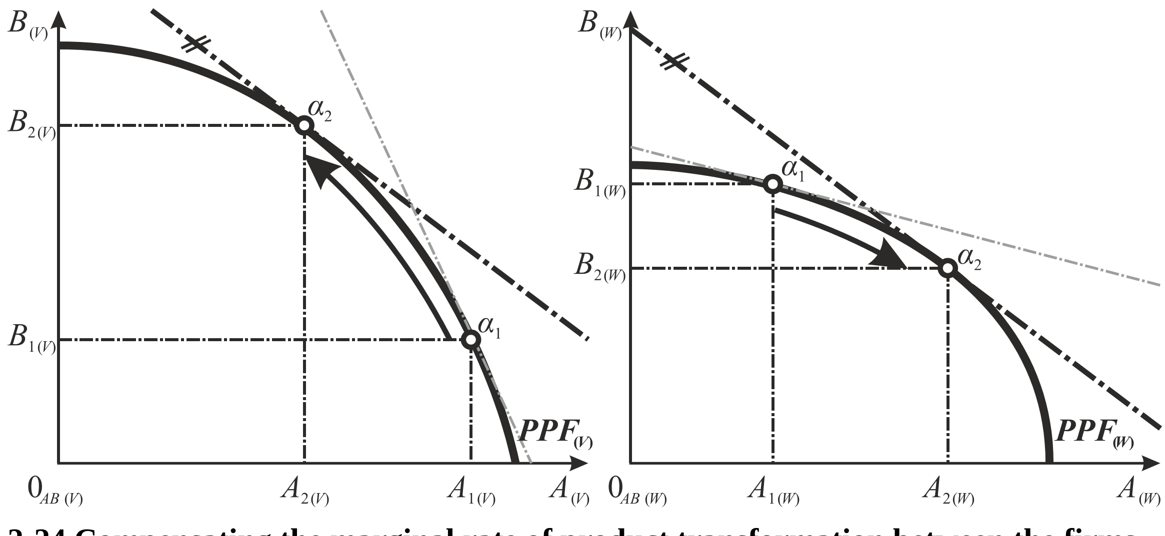
2-23 Compensating marginal products between the firms *V* and *W*

2.5.3 The third allocation rule

The third condition of production efficiency (the 3rd allocation rule) is to ensure the structure of production of both commodities *A* (apples) and *B* (bananas) at which the marginal rate of product transformation is the same for both the firms V and *W*.

To derive a socially efficient point, it would be necessary to include consumer's preferences.

$$MRPT_V = MRPT_W \tag{2.30}$$

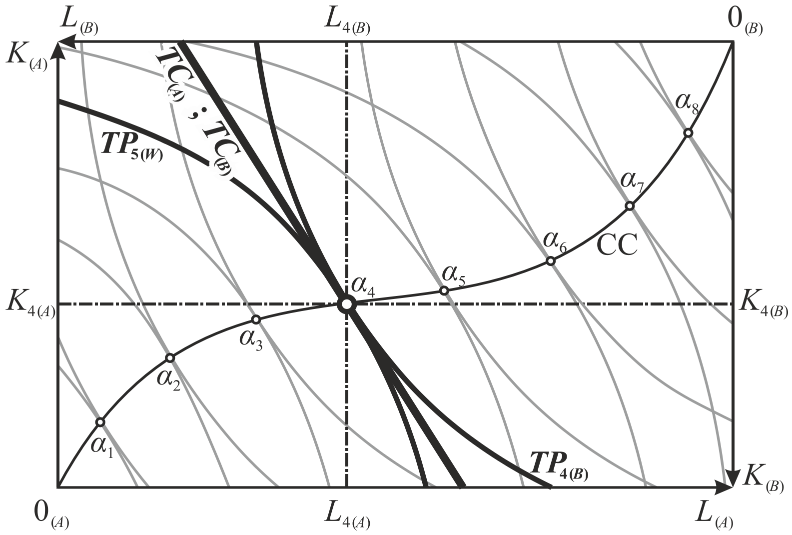


2-24 Compensating the marginal rate of product transformation between the firms *V* and *W*

2.5.4 Prices of production factors

It is necessary to include prices of production factors (prices of production factors are specified according to the market while compensating the demanded and supplied amount of the production factors) in the solution of final **production efficiency**. Pareto-efficient allocation is such a final allocation of production sources for which it applies that it is not possible to redistribute a disposable quantity of inputs between the production of two commodities so that increasing the production of one of the firms would not lead to decreasing the production of the other firm. For solving the production efficiency, it must apply:

$$MRTS_{K,L(V)} = MRES = \frac{w}{r} = MRTS_{K,L(W)} \tag{2.31}$$

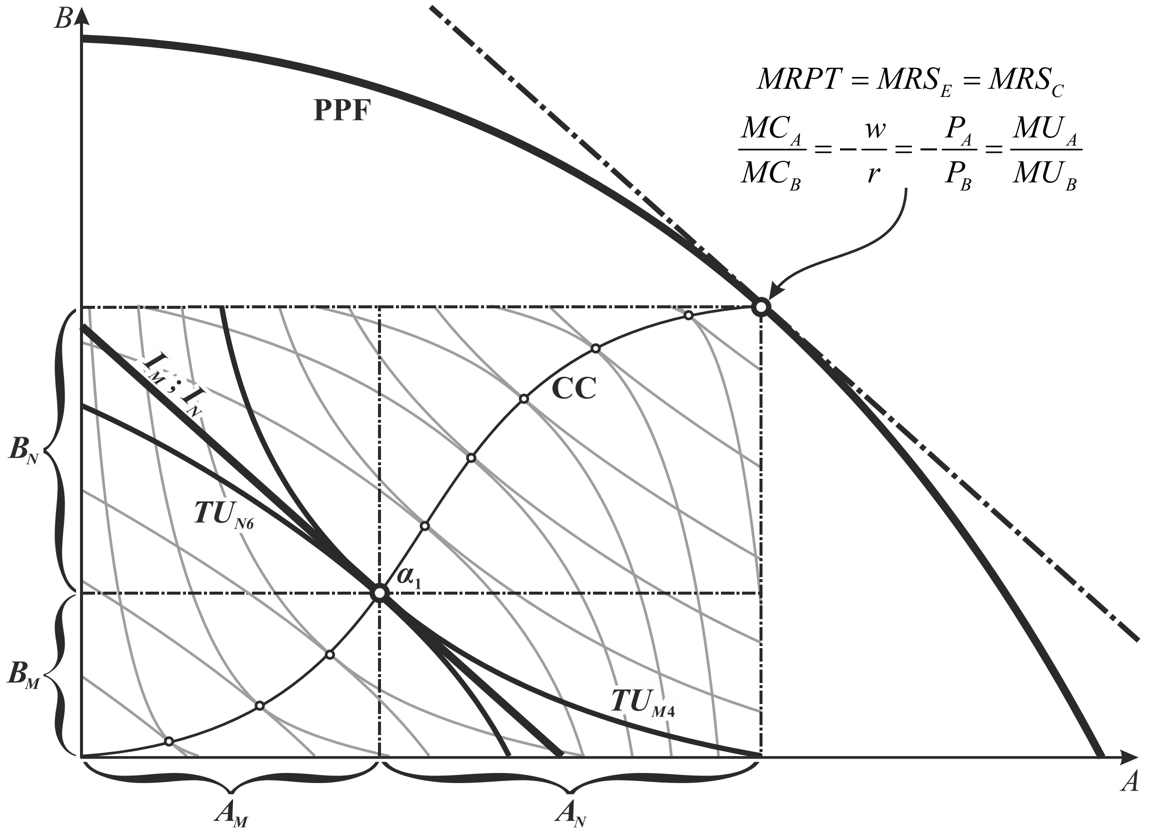


2-25 Prices of production factors and efficient allocation

2.6 Production and consumption efficiency

The production and consumption efficiency or general equilibrium is the state when the consumer's equilibrium and production equilibrium are reached at the same time. For simplicity, the production and consumption efficiency is applied in the **model 2-2-2-2**: two firms *V* and *W*, two products *A* (apples) and *B* (bananas), two production factors *K* (capital) and *L* (labour), two consumers *M* (Martin) and *N* (Nancy). Thus, the model brings together the presumption of two consumers and two products, which we specified in the chapter 1.9 devoted to the consumption efficiency, and the presumption of two producers, two products and two production factors, which we used in the chapter 2.5 focused on the production efficiency. In the Edgeworth box diagram, the Pareto efficient equilibrium when two firms *V* and *W*, by using the Pareto-efficient allocation of two production factors *K* (capital) and *L* (labour), at prices of production factors *r* (rate of interests) and *w* (wage rate), produce such a combination of the quantity of the goods *A* (apples) and *B* (bananas), which is considered as Pareto-efficient by two consumers *M* (Martin) and *N* (Nancy), who buy for the prices P_A and $P_{B.}$ For the production and consumption efficiency, it then applies:

$$MRPT = MRS_E = MRS_C \tag{2.32}$$



2-26 Production and consumption efficiency

From the graph 2-26, it is clear that all manufactured outputs of apples *A* and bananas *B* are consumed. However, Martin buys fewer bananas and apples compared to Nancy ($A_M < A_N$ and $B_M < B_N$). It is given by income distribution between both the consumers. From the position of the budget line I_M ; I_N, it is clear that the income I_N, which is available to Nancy, is higher (it offers a higher number of budgetary possibilities) compared to the budget of Martin I_M. Then, the slope of the budget line also indicates that the price of apples on the market is lower than the price of bananas.

Further Reading

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